



# **FIVE QUESTIONS – ONE MISSION**

## **Better Lives for Kentucky's People**

### **Strategy for Statewide Engineering in Kentucky: A Review 2001 - 2006**

**Council on Postsecondary Education**

**January 2007**



Leon Zernitsky/SIS Illustrations



## **Strategy for Statewide Engineering Education in Kentucky A Review 2001- 2006**

In 2000, the Council on Postsecondary Education approved a *Statewide Strategy for Engineering Education in Kentucky* to integrate secondary, baccalaureate, and post-baccalaureate programs to address the need for a highly skilled workforce tied to the state and nation's economic strength. (Appendix I) The strategy involved secondary schools, public postsecondary institutions, including the Kentucky Community and Technical College System (KCTCS), Association of Independent Kentucky Colleges and Universities (AIKCU), and the Kentucky Virtual University (KYVU), now the Kentucky Virtual Campus (KYVC). This report documents the impact of this strategy since its inception.

The strategy was developed in collaboration with the deans of Kentucky's engineering schools, KCTCS, and members of the practicing engineering community. Its purpose was to meet two primary needs:

- Increase the number of baccalaureate engineers in Kentucky.
- Increase greater geographic access and productivity in engineering education.

Postsecondary institutions play pivotal roles in the economy of Kentucky by recruiting and producing graduates in STEM fields of study (science, technology, engineering, and mathematics). To sustain the intellectual, social, cultural, and economic development of the Commonwealth, both two- and four-year institutions must work collaboratively to develop a pipeline of students from Kentucky's secondary school students prepared to study the STEM disciplines.

The strategy included plans to encourage graduate study in engineering at the research institutions utilizing state-of-the-art recruiting, mentoring, and placement initiatives for students, inclusive of women and minorities. Building on the strengths of the existing engineering programs at the research institutions, one of the first initiatives was to develop joint engineering degree programs. This was done through collaboratives between the University of Kentucky (UK) and the University of Louisville (UofL) offering joint programs at two of the comprehensive institutions, Murray State University (MuSU) and Western Kentucky University (WKU). The structure of these programs was to reflect the needs of area employers and the strengths of the

institutions involved in each program, while providing greater geographical access for students. Appropriate faculty at each participating institution agreed to appointments, tenure, and promotion policies, the allocation of equipment and facilities, the provision of student services, assessment criteria, and the general management of the joint programs. KCTCS was responsible for developing pre-engineering curricula through *transfer critical courses* that would enable community and technical college graduates to meet all third-year engineering entrance requirements of Kentucky's public baccalaureate institutions. KCTCS also was to develop additional engineering technology programs at the associate degree level.

In addition to the joint programs developed, through the UK and UofL with MuSU and WKU, other comprehensive universities continue to offer baccalaureate degrees in engineering technology. UK and UofL have additional programs in engineering at the baccalaureate, master's, and doctoral degree levels. In addition to these joint programs, other ABET-accredited programs are offered by Kentucky postsecondary institutions in applied science, computing, and technology (Appendix II).

A key component of the statewide joint engineering strategy is to increase the number of Kentucky high school graduates prepared to succeed in engineering programs at the postsecondary level. In 2006-08, the Council requested funding to assist the Kentucky Department of Education (KDE) in developing an articulated engineering pipeline to increase the number of Kentucky students prepared for engineering degrees through implementation of Project Lead The Way® (PLTW), the model pre-engineering curriculum recommended in the 2006 National Academies Report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*.

In the summer of 2006, five years since the Council approved the strategy, an analysis of the joint programs was conducted through reviewing the data and information submitted to the Council by the research staff, engineering deans, and faculty at each of the participating universities. Analysis of these data may be found in Appendix III. Beginning in the 2002-03 academic year, the four institutions working jointly to increase engineering education statewide were funded annually at \$1,000,000 (\$125,000 per program, per institution). Fiscal reporting of the programs may be found in Appendix IV.

The following is a summary of the information provided about the engineering and engineering technology programs between 2001 and 2005:

### Degrees

- Degrees and formal awards conferred in engineering and engineering technology increased at all levels, **except** baccalaureate degrees (Figure 2).
- Certificate completions increased substantially more than any other level of engineering degree or formal award (Figure 2).
- Engineering baccalaureate degrees declined while the total number of baccalaureate degrees conferred, across all disciplines, increased significantly (Table 1). The pattern of production shows a decline through 2004 with a significant increase between 2004 and 2005.
- Graduate degree production increased significantly with a 25 percent increase in master's in engineering and 72 percent increase in master's in engineering technology while the doctoral degrees have tripled (Figure 2).
- In the joint engineering disciplines, degrees in civil and mechanical engineering increased while electrical engineering degree production decreased (Table 3b).
- Engineering and engineering technology baccalaureate degrees show similar patterns of modest decline (Figure 1).
- The proportion of engineering and engineering technology baccalaureate degrees awarded to females and to African American graduates is fairly constant and remains below national averages (Table 2).
- Engineering and engineering technology baccalaureate degrees awarded to international students (non-resident aliens) declined significantly during 2001-05 and were below national proportions (Table 2).
- Among the engineering technology program disciplines, degrees in computer engineering and industrial/manufacturing engineering showed the greatest increase while architectural engineering technology and occupational safety and health showed significant declines (Table 3a).
- Baccalaureate degrees conferred in civil and mechanical engineering showed the greatest increase. Significant declines in electrical and chemical engineering baccalaureate degrees were evident during this time (Table 3b).
- To date, only Western Kentucky University has graduated students from the joint engineering programs at the comprehensive institutions (Tables 6a-6d).



### Enrollment

- Between 2000 and 2005, enrollment in engineering baccalaureate programs increased by 13 percent and enrollment in the three joint program disciplines increased 25 percent (Table 7b). During the same time, baccalaureate enrollment in engineering technology programs decreased by 5 percent (Table 7a).
- In 2004-05, enrollment in the joint engineering program at Western Kentucky University was substantially greater than at Murray State University (Table 8).
- The number of applicants to the joint engineering programs at the comprehensive universities has more than tripled since 2002, although the growth is not consistent each year (Table 9).
- Transfer students from KCTCS institutions admitted to the joint engineering programs have increased each year, up to 21 students in 2006 (Table 10a).
- KCTCS transfers into baccalaureate engineering programs at the research universities have not increased in the last five years and, in fact, UK has reported a decline of 27 percent of transfer students between 2001 and 2004, while the UofL enrollments are unchanged over the same period (Table 10b).

### Funding

- During 2003 to 2006, \$4 million in state funds has been expended for the joint engineering programs.
- MuSU, WKU, and UK leveraged over \$3.5 million in additional institutional and matched support; an additional \$4.8 million was realized in tuition and fees.
- Faculty costs exceed the state allocations by over \$3.5 million.
- Funds utilized for scholarships totaled \$35,092.
- Operating expenses totaled over \$4.6 million.
- Carry forward for fiscal year 2006-07 totaled \$605,895.

### Outcomes

- Capacity and geographic access to engineering degree programs have increased with the four joint programs at WKU and MuSU (Appendix III, Table 5).
- WKU has ABET-accredited programs in all three joint engineering programs (Appendix II).

- The overall pass rates of the Fundamentals of Engineering Examination are comparable between comprehensive and research universities (Appendix III, Table 11).
- Trend data between 2000 and 2005 show an increase of 16 percent in the number of participants from Kentucky institutions taking the Fundamentals of Engineering Examination (the first exam taken by potential licensees) (Figure 11) while the number of licensed engineers in Kentucky for this time period increased by 33 percent (Figure 12).
- Recent awards totaling \$650,000 were made to 13 school districts across the Commonwealth to implement or expand the Project Lead The Way® curriculum. The staff of the Council and the Kentucky Department of Education are working to select a postsecondary institution to serve as a university affiliate for the program. This affiliate institution will work in collaboration with K-12 teachers, training teachers in the PLTW curriculum and evaluating such programs in Kentucky.

## Conclusions

The establishment of three new ABET-accredited joint engineering programs at WKU will allow Kentucky to capitalize on the recent enrollment increases in baccalaureate engineering programs. Degree output has been modest but consistent in the early years of the program. The three accredited joint programs only recently began to produce graduates. Their numbers should continue to grow. Earning ABET accreditation at MuSU, an original goal for the strategy, has not yet been achieved. This program should be important if efforts to strengthen the pipeline result in greater numbers of highly qualified engineering undergraduate students.

The joint programs have not used all of the allocated funds. Distance learning education research indicates ITV as one method of delivery, but finds students who are *digital natives* prefer Web-enhanced instructional design, which maximizes effectiveness and student learning. The ITV used in these joint programs has met with some difficulty both in meeting students' expectations and as a reliable method of curricula delivery. The unallocated funds could be used to reassess the programs to identify which courses are best taught by the University of Kentucky and the University of Louisville at the comprehensive campuses, then redesign those courses to take full advantage of current best practices in distance learning.

Strategy funds also could be used to support efforts to improve the pipeline for engineering programs: providing high-quality professional development for middle and high school teachers

in the PTLW program and elsewhere, and developing programs to recruit and retain students in these pre-engineering programs, especially women and minorities. Finally, *transfer*-critical pre-engineering courses should be developed at selected KCTCS institutions which currently have the capacity but not the courses to support pre-engineering students.

Council data and institutional reports provided for this review indicate that Kentucky's postsecondary engineering and engineering technology programs provide the Commonwealth with the capacity to meet near-term workforce needs. However, two concerns remain:

- This capacity could well be underutilized if the K-14 pipeline to draw students into baccalaureate engineering programs is not enlarged. The number of Kentucky students expressing interest in engineering careers and preparing for these careers is declining, while the need for baccalaureate engineering degree-holders is increasing nationwide and internationally.
- If baccalaureate engineering degree production increases, or is even sustained without additional jobs being generated in Kentucky, graduates from these programs will leave the state. Students at both the postsecondary and pre-baccalaureate level need to be trained to "think entrepreneurially" in order to generate jobs in-state, as well as to attract jobs and employers from out-of state.

Some would suggest that engineering degree production is reasonable for the number of statewide engineering employment opportunities. While increasing the number of engineering graduates to work in the global economy and in Kentucky's competition for economic development, degree production and employment opportunities must be aligned on both fronts.

The joint degree programs have increased geographical access and are producing growing numbers of graduates, while enrollments and degrees have declined in the University of Kentucky programs. However, the University of Kentucky's dean of engineering indicated that the number of students from the western part of the state has not declined, indicating the joint programs are serving the purpose of making engineering available to students in that region who might not otherwise pursue the degree. All of this suggests the larger pipeline problem, one Kentucky shares with much of the nation.

The following recommended changes in the statewide strategy are in part designed to address this pipeline problem and the findings of this review.

## Recommendations

### Pipeline

1. Increase the pipeline of prepared students for baccalaureate engineering programs by improving middle and high school mathematics and science curricula and instruction.
  - a. Expand implementation of PLTW and designate a PLTW-affiliate university.
  - b. Increase dual credit opportunities in STEM fields.
  - c. Expand KCTCS engineering pre-requisite curricula.
  - d. Provide support to transfer students in engineering baccalaureate programs using transfer scholarship funds allocated to KCTCS for 2007-08 and matching university scholarships.
  - e. Improve the quality of teacher preparation and professional development in STEM disciplines through collaboration between colleges of engineering and colleges of education.
2. Target recruitment, financial aid, and compensation strategies to attract and retain K-14 instructors in STEM disciplines.
3. Target women, minorities, and rural students with aggressive recruitment efforts and financial aid incentives. Increase Kentucky's enrollment and degree production rates of women and minorities to those of the nation.

### Program Modifications

4. Provide faculty review of engineering offerings at the joint colleges to utilize advanced expertise of the research institutions.
5. Use unexpended funds to redesign both shared and specialized courses, employing best practices in the delivery of distance learning curricula in consultation with the Kentucky Virtual Campus. Priority should be given to the joint electrical programs.
6. Allow MuSU to expand their ABET-accredited engineering physics program by utilizing joint engineering program funds, contingent upon achieving ABET accreditation of the MuSU/UofL joint electrical engineering program by 2009-10.
7. Reward WKU's success in leveraging funding for the joint engineering program by moving the current funding allocations to WKU's base funding.
8. Apply lessons learned from WKU's accreditation and funding success to strengthen the statewide strategy.

9. Present this engineering report to the Council's Research, Economic Development, and Commercialization Policy Group to address the job creation component of the Statewide Engineering Strategy - - including economic development, innovation, commercialization, and entrepreneurship.

#### Work and Industry Partners

10. Work with representatives of joint programs in electrical engineering and the KCTCS to target this area of program development.
11. Increase engagement of the engineering industry and other state partners (e.g. Kentucky Engineering Center, Chambers of Commerce, Department for Workforce Investment, and Department of Commercialization and Innovation) in the strategic plan to improve engineering education in Kentucky.
  - a. Investigate further the need for engineers in Kentucky based on current job openings and planned economic development.
  - b. Develop early career awareness through public communication and direct K-12 engagement.
  - c. Expand the provision of scholarships and internships for engineering candidates.
  - d. Provide competitive salaries to prevent out migration of Kentucky's engineering graduates. (Note: Council staff is currently assembling data on migration patterns detailing in- and out-migration in STEM disciplines.)

## **Appendix I**

### **Statewide Strategic Plan for Engineering Education**



# **STRATEGY FOR STATEWIDE ENGINEERING EDUCATION IN KENTUCKY**

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**ACTION**  
**Agenda Item D-1**  
**July 17, 2000**

## **Recommendation:**

- That the Council approve the attached "Strategy for Statewide Engineering Education in Kentucky."
- That the Council instruct staff to expedite reviews of all proposed programs that fall within this strategy.
- That the Council commend the presidents, chief academic officers, and members of institutional faculties and staffs for working together to develop this strategy quickly.

## **Rationale:**

- This statewide strategy takes advantage of the substantial resources invested in engineering, science, and technology while creating programs that are multi-institutional, and available throughout the state, and that meet the needs of traditional and nontraditional students as well as practitioners.
- This strategy reflects the intent of *The Postsecondary Education Improvement Act of 1997* and the Council's *Action Agenda*: to grow responsibly, to focus on the highest possible quality, to use resources effectively, to use technology wisely, to target underserved areas, and to help employers be successful.
- The need for expanded engineering education is immediate and requires that programs of high quality be developed, approved, and implemented as quickly as possible.

## **Background:**

At its March 2000 meeting, the Council requested that the University of Kentucky, the University of Louisville, Western Kentucky University, and Council staff, in consultation with the other comprehensive universities and the Kentucky Community and Technical College System, design a proposal to expand engineering education in Kentucky.

Since the March meeting, the presidents of Kentucky's universities, the president of the KCTCS, and the chief executive officer of the Kentucky Commonwealth Virtual University have met several times with Gordon Davies and Sue Hodges Moore and held a joint meeting with chief academic officers and faculty representatives. The chief academic officers and faculty representatives also met to discuss the strategy.

The strategy has been signed by the presidents, with the exception of Dr. Charles Wethington, University of Kentucky, who is consulting with the UK engineering faculty.

## **Strategy for Statewide Engineering Education in Kentucky July 17, 2000**

Kentucky needs a statewide strategy to educate more engineers and to integrate engineering education more closely into the technology-driven "New Economy." The Council on postsecondary Education, at its March 20, 2000, meeting, approved the recommendation that the public universities and colleges work together with the Council staff to design a statewide strategy to expand engineering education. The statewide strategy is intended to meet two primary needs:

1. the need to increase the number of baccalaureate engineers in Kentucky, and
2. the need to address regional issues of access and productivity in engineering education.

Kentucky's progress in meeting these needs will be assessed periodically by the Council and all participating institutions.

The strategy for engineering education in Kentucky will eventually integrate secondary, baccalaureate, and post-baccalaureate programs. It will involve secondary schools, the Kentucky Community and Technical College System, the comprehensive universities, the research universities, the independent colleges and universities, and the Kentucky Commonwealth Virtual University.

Access to undergraduate engineering education will expand primarily through the creation of joint programs managed by multiple postsecondary institutions. The programs will be tailored to meet demonstrated regional or statewide needs. They will be separately accredited and degrees will be conferred jointly. All participating institutions will be involved in program development, delivery, and administration. Students will be able to complete all degree requirements at their home campus through resident instruction, courses delivered through the Kentucky Commonwealth Virtual University, or courses delivered by participating institutions through other distance delivery methods.

The Council would like to consider the first joint program proposals as early as November 2000. The Council will accelerate the approval process for joint programs that satisfy the criteria outlined in this strategy document's final form.

The joint programs should build on the strengths of existing engineering programs at the University of Kentucky and the University of Louisville while accommodating employer needs identified by the comprehensive institutions. The University of Kentucky and the University of Louisville will agree which institution will have the responsibility for statewide development of joint programs by discipline with interested comprehensive institutions. All joint programs will become separately accredited by the Engineering Accreditation Commission of the accreditation Board for Engineering and Technology (EAC/ABET) as soon as possible.

During the start-up phase of each joint program, the deans of engineering at the University of Kentucky and the University of Louisville will, on behalf of all participating institutions, recommend that the Kentucky State Board for Licensure for Professional Engineers and Land Surveyors grant approval to the joint program so that students may sit for the appropriate Engineering Fundamentals Examination administered by the board twice yearly in Lexington and Louisville.

The specific structure of each joint program may differ from one another, depending on the needs of area employers and the strengths of the institutions involved in each program. Prior to submitting a proposal for the Council's consideration, the appropriate faculty of each participating institution will agree on the appointment, tenure, and promotion policies for program faculty, the allocation of equipment and facilities, provision of student services, assessment criteria, and the general management of the joint program. Decisions regarding the salary, rank, and tenure of individual faculty members will be the responsibility of the employing institution. Adjunct or joint appointments to the faculty of the other participating institution(s) may be offered.

The Council staff will recommend to the Council appropriate funding for the equipment and facilities needs of the strategy as the Council develops its operating and capital budget recommendations for the next biennium. Funding could also be sought in the 2002 Legislative Session as part of the "New Economy" initiatives authorized in House Bill 572 of the 2000 session.

Working with the institutions, the Council will develop procedures for counting enrollments and graduates, disbursing funds, and establishing tuition rates.

The strategy is open to selected, non-duplicative, stand-alone engineering programs at comprehensive universities as well as to other types of multi-institutional arrangements. The strategy also envisions the continued strengthening and expansion of the existing engineering programs at the University of Kentucky and the University of Louisville and the development of new undergraduate and graduate engineering programs that support the strategic plans of both institutions and the "New Economy" initiatives.

The Kentucky Community and Technical College System and Lexington Community College will develop pre-engineering curricula (in conjunction with the University of Kentucky and the University of Louisville) that will enable community and technical college graduates to meet all third-year engineering entrance requirements of Kentucky's public baccalaureate institutions. In addition, the Kentucky Community and Technical College System and Lexington Community College may develop additional Engineering Technology programs at the associate degree level. The universities may also work with the Kentucky Community and Technical College System and Lexington Community College to offer such programs and to align associate and baccalaureate engineering technology programs. These programs will become accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC/ABET) as soon as possible.

The strategy will encourage recruiting, mentoring, and placement initiatives for women and minorities.

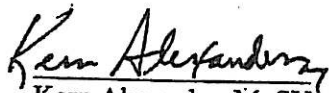
The strategy envisions the creation of a clearinghouse for information about student engineering employment opportunities, including cooperative education, summer internships, and permanent employment with Kentucky businesses and industries.

Students at participating institutions will be encouraged to apply for graduate study in engineering at the University of Kentucky and the University of Louisville. Engineering articulation agreements, early admissions policies, and other strategies will be used to make the transition to graduate study as smooth as possible. The strategy is also open to the use of comprehensive institutions as remote sites for the delivery of master's programs of the University of Kentucky and the University of Louisville through resident instruction, courses

delivered through the Kentucky Commonwealth Virtual University, or courses delivered through other distance delivery methods.

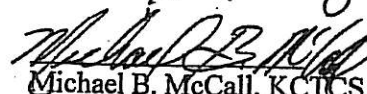
The Council will play its usual coordinating role in the development and implementation of the strategy, including adjudicating disputes, facilitating statewide discussions, measuring effectiveness, and determining statewide funding and construction needs.

Signed July 5, 2000

  
Kern Alexander, MuSU

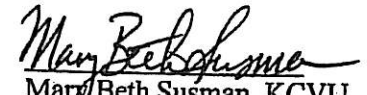
  
Ronald G. Eaglin, MoSU

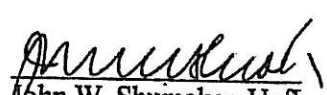
  
Robert Kustra, ECU

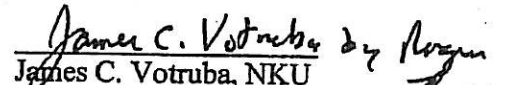
  
Michael B. McCall, KCICS

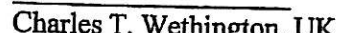
  
Gary A. Ransdell, WKU


  
George W. Reid, KSU

  
Mary Beth Susman, KCVU

  
John W. Shumaker, UofL

  
James C. Votruba, NKU

  
Charles T. Wethington, UK

  
Gordon K. Davies, CPE

## Appendix II

### Kentucky's ABET-Accredited Programs

Institution	Review Date	Program	Level (Degrees)	Since	Program
EKU	2005-06	Computer Science w/concentration in Gen Computer Science	BS	1991	Computing
MuSU	2010-11	Occupational Safety & Health	BS	1988	Applied Science
	2010-11	Occupational Safety & Health	MS	1988	Applied Science
	2009-10	Engineering Physics	BS	1998	Engineering
	2010-11	Civil Engineering Technology	BS	1990	Technology
	2010-11	Construction Engineering Tech Option of Civil Engineering Technology	BS	1981	Technology
NKU	2007-08	Electronic Engineering Technology	BS	1996	Technology
	2007-08	Manufacturing Engineering Technology	BS	1996	Technology
UK Paducah -	2008-09	Chemical Engineering	BSCME	2003	Engineering
UK Paducah -	2008-09	Mechanical Engineering	BSME	2003	Engineering
UK	2011-12	Computer Science	BSCS	2006	Computing
	2010-11	Bio-systems & Agricultural Engineering	BSBAE	1967	Engineering
	2010-11	Chemical Engineering	BSCHE	1969	Engineering
	2010-11	Civil Engineering	BSCE	1936	Engineering
	2010-11	Electrical Engineering	BSEE	1940	Engineering
	2010-11	Materials Engineering	BSMAE	1936	Engineering
	2010-11	Mechanical Engineering	BSMEE	1940	Engineering
	2010-11	Mining Engineering	BSMIE	1936	Engineering
UofL	2007-08	Computer Engineering & Computer Science	BS	1996	Computing
	2006-07	Chemical Engineering	ME	1936	Engineering
	2006-07	Civil Engineering	ME	1936	Engineering
	2006-07	Electrical Engineering	ME	1936	Engineering
	2006-07	Computer Engineering & Computer Science	ME	1983	Engineering
	2006-07	Industrial Engineering	ME	1983	Engineering
	2006-07	Mechanical Engineering	ME	1936	Engineering
WKU	2007-08	Computer Science – Scientific Option	BS	1993	Computing
	2010-11	Civil Engineering	BS	2005	Engineering
	2010-11	Electrical Engineering	BS	2005	Engineering
	2010-11	Mechanical Engineering	BS	2005	Engineering

Accrediting Board for Engineering and Technology as of October 1, 2006. ABET accredits postsecondary degree-granting programs housed within regionally accredited institutions. ABET accredits programs only, not degrees, departments, colleges, or institutions.



## Appendix III

Table 1. Baccalaureate Degrees Conferred, All Kentucky Institutions

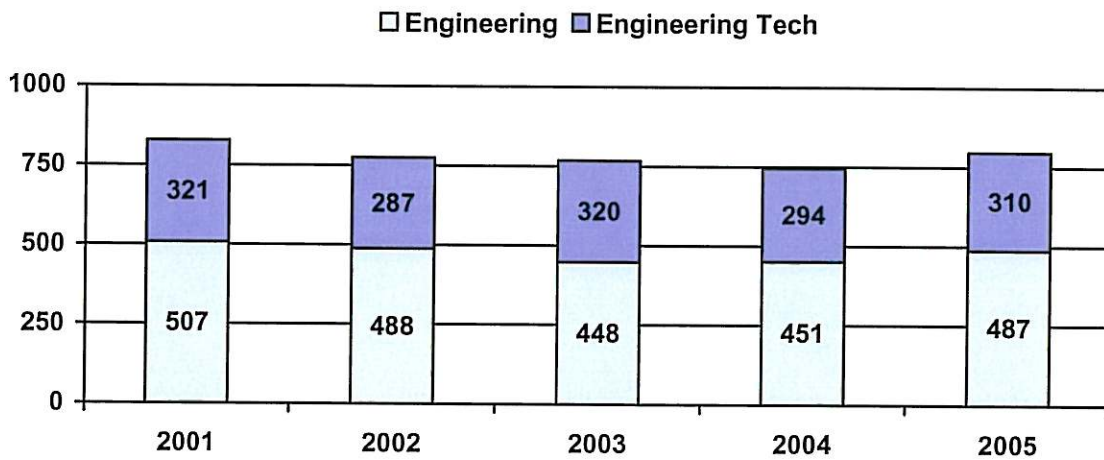
	2001	2002	2003	2004	2005	4-year % Change
Engineering & Engineering Technology	828	775	768	745	797	-3.7
All Other Baccalaureates	14,572	15,593	15,432	16,470	17,014	16.8
<b>Total</b>	<b>15,400</b>	<b>16,368</b>	<b>16,200</b>	<b>17,215</b>	<b>17,811</b>	<b>15.6</b>
Percent Engineering & Engineering Technology Degrees of Total	5.3	4.7	4.7	4.3	4.5	

### Engineering Degree Production Trends

Engineering baccalaureate degrees awarded are the key deliverables of the statewide engineering strategy. Engineering technology program graduates are not eligible to be licensed and are less likely to establish independent businesses that contribute to the local economy.

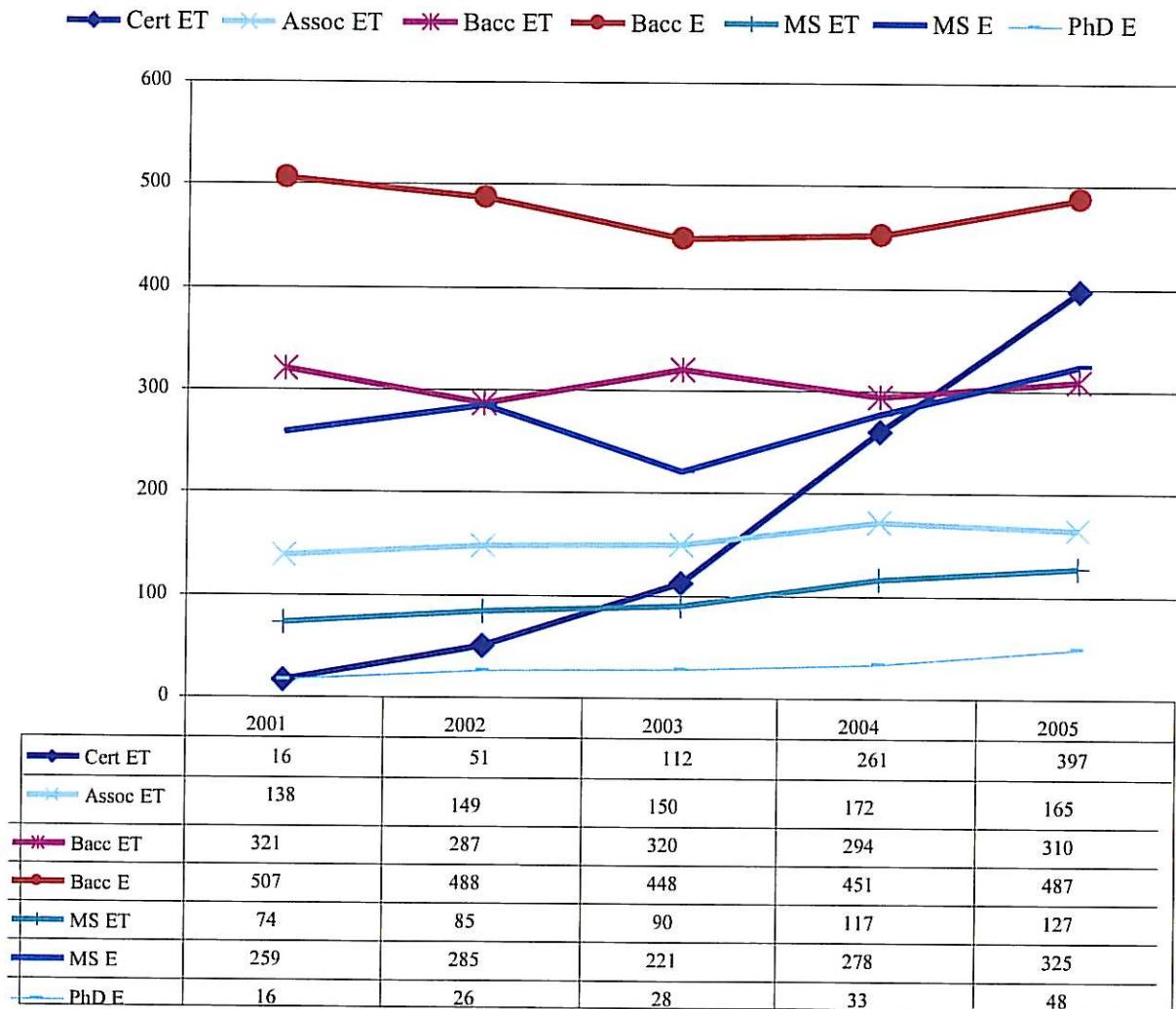
Table 1 illustrates the overall decline in baccalaureate degrees in Engineering and Engineering Technology, in spite of an increase in 2005. Also, with significantly greater degree production at the universities, engineering degrees now account for a smaller share of all baccalaureate degrees awarded. Engineering and engineering technologies degrees accounted for 5.6 percent of all baccalaureate degrees awarded in the U.S. in 2004 (NCES, Digest of Education Statistics, 2005, Table 249).

Figure 1. Engineering and Engineering Technology Baccalaureate Degrees Conferred



The proportion of engineering (Classification of Instructional Programs Code 14) to engineering technology (Classification of Instructional Programs Code 15) degrees is shown in Figure 1. Engineering typically accounts for sixty percent of the combined baccalaureate degrees. Both types of engineering degrees have declined slightly since 2001, although the numbers of engineering degrees have increased in 2004 and 2005 for engineering degrees (CIP 14).

Figure 2. Degrees Awarded by Level in Engineering and Engineering Technology



All degree levels and formal awards in Engineering and Engineering Technology (ET) increased between 2001 and 2005, except baccalaureate degrees (Figure 2). The count of ET certificates showed the largest increase, from just 16 certificates in 2001 to 397 certificates awarded in 2005. Engineering and engineering technology combined produced 119 more master's degrees awarded in 2005 than in 2001 and 32 more engineering doctoral degrees produced.

Table 2 - Demographic Characteristics of Baccalaureate Engineering and Engineering Technology Graduates, 2001 – 2005

	2001		2002		2003		2004		2005	
	N	%	N	%	N	%	N	%	N	%
<b>US Total Graduates</b>	<b>72,975</b>		<b>74,679</b>		<b>77,267</b>		<b>78,227</b>			
<b>KY Total Graduates</b>	<b>828</b>		<b>775</b>		<b>768</b>		<b>745</b>		<b>797</b>	
Female	143	17.3	143	18.5	130	16.9	141	18.9	137	17.2
Male	685	82.7	632	81.5	638	83.1	604	81.1	660	82.8
African American	31	3.7	31	4.0	30	3.9	34	4.6	31	3.9
White, Non-Hispanic	719	86.8	673	86.8	686	89.3	665	89.3	717	90.0
Hispanic	1	.1	4	.5	6	.8	4	.5	8	1.0
Asian	19	2.3	29	3.7	11	1.4	21	2.8	19	2.4
Nonresident Alien	52	6.3	36	4.6	30	3.9	18	2.4	19	2.4
Other	6	.7	2	.3	5	.7	3	.4	3	.4
KY Resident	678	81.9	620	80.0	633	82.4	607	81.5	660	82.8
Non Resident	67	8.1	78	10.1	53	6.9	55	7.4	57	7.2

As noted in Table 2 the proportion of female engineering and engineering technology graduates has remained relatively stable at nearly 17 percent. This proportion is lower than the national percentage of female baccalaureate graduates for 2004, or 18.8 percent (NCES, Digest of Education Statistics, 2005, Table 281). The proportion of African American engineering and engineering technology graduates has remained relative stable at 4 percent, except for 2004 when the proportion increased to 4.6 percent. In 2003 the percentage of African American baccalaureate recipients in the U.S. was 6.2 percent (NCES, Digest of Education Statistics, 2005, Table 263).

Kentucky resident graduate production has been fairly consistent recently at 82 percent. The proportion of non-resident graduates, which includes both out-of-state and international graduates, has remained at roughly 7 percent since 2003. An indication of the decline of international students at the baccalaureate level is the proportion of Nonresident Alien graduates in the race-ethnic category. Nonresident aliens, according to the federal postsecondary education reporting definitions, are not permanent residents or citizens of the United States. The proportion of graduates in this race-ethnic category has declined from 6.3 percent down to just 2.4 percent. In the US, in 2003, 6.2 percent of the baccalaureate engineering and engineering technology degrees conferred was awarded to Nonresident Aliens (NCES, Digest of Education Statistics, 2005, Table 263).

The total U.S. baccalaureate degrees awarded in engineering and engineering technology increased 7.2% between 2001 and 2004, while Kentucky numbers declined by 10%. (NCES, Digest of Education Statistics, 2005, Table 249).

Table 3a - Baccalaureate Degrees Awarded in Engineering Technology Disciplines  
Kentucky, 2001 – 2005

Engineering Technology Program	2001	2002	2003	2004	2005	4-Year Change
Architectural Engineering	51	41	43	44	25	-26
Occupational Safety and Health	46	34	40	43	27	-19
Mechanical Engineering/Mechanical	13	6	8			-13
Electrical, Electronic/Communications Engineering	23	19	29	23	13	-10
Civil Engineering	18	24	25	15	15	-3
Environmental Engineering	3	4	4	6	7	4
Water Quality/Wastewater Treatment/Recycling	22	25	28	29	29	7
Computer Electronic Networking/Systems	1	8	14	13	25	24
Industrial/Manufacturing	144	126	129	121	169	25
<b>Grand Total</b>	<b>321</b>	<b>287</b>	<b>320</b>	<b>294</b>	<b>310</b>	<b>-11</b>

Table 3b - Baccalaureate Degrees Awarded in Engineering Disciplines  
Kentucky, 2001 - 2005

Engineering Program	2001	2002	2003	2004	2005	4-Year Change
<b>Electrical, Electronics/Communications</b>	<b>120</b>	<b>98</b>	<b>83</b>	<b>86</b>	<b>93</b>	<b>-27</b>
Chemical Engineering	69	53	52	53	46	-23
Mining and Mineral Engineering	10	3	1	3	2	-8
Industrial/Manufacturing Engineering	24	12	18	17	21	-3
Applied Science-Engineering Transfer	4	3	1		4	0
Materials Engineering	4	7	1	1	4	0
Agricultural/Biological and Bioengineering	8	12	14	11	10	2
Computer Engineering, General	35	40	34	43	41	6
Engineering Physics	9	11	8	5	15	6
<b>Civil Engineering, General</b>	<b>113</b>	<b>121</b>	<b>106</b>	<b>110</b>	<b>123</b>	<b>10</b>
<b>Mechanical Engineering</b>	<b>111</b>	<b>127</b>	<b>129</b>	<b>121</b>	<b>128</b>	<b>17</b>
<b>Grand Total</b>	<b>507</b>	<b>488</b>	<b>448</b>	<b>451</b>	<b>487</b>	<b>-20</b>

**Bold** indicates joint engineering discipline.

Baccalaureate degrees awarded since 2001 in both engineering technology (Table 3a) and in engineering (Table 3b) are provided. In Kentucky's engineering technology programs, the significant increases were made in industrial/manufacturing and computer/electronic networking. In the engineering disciplines, Civil and mechanical engineering degrees showed modest increases. Electrical, electronic/communications engineering and chemical engineering degrees show the largest declines. This represents a decline over the last five years of 3.0 percent in engineering technology and a 3.9 percent in engineering.

Figure 3. Baccalaureate Degrees in Engineering Disciplines, Kentucky

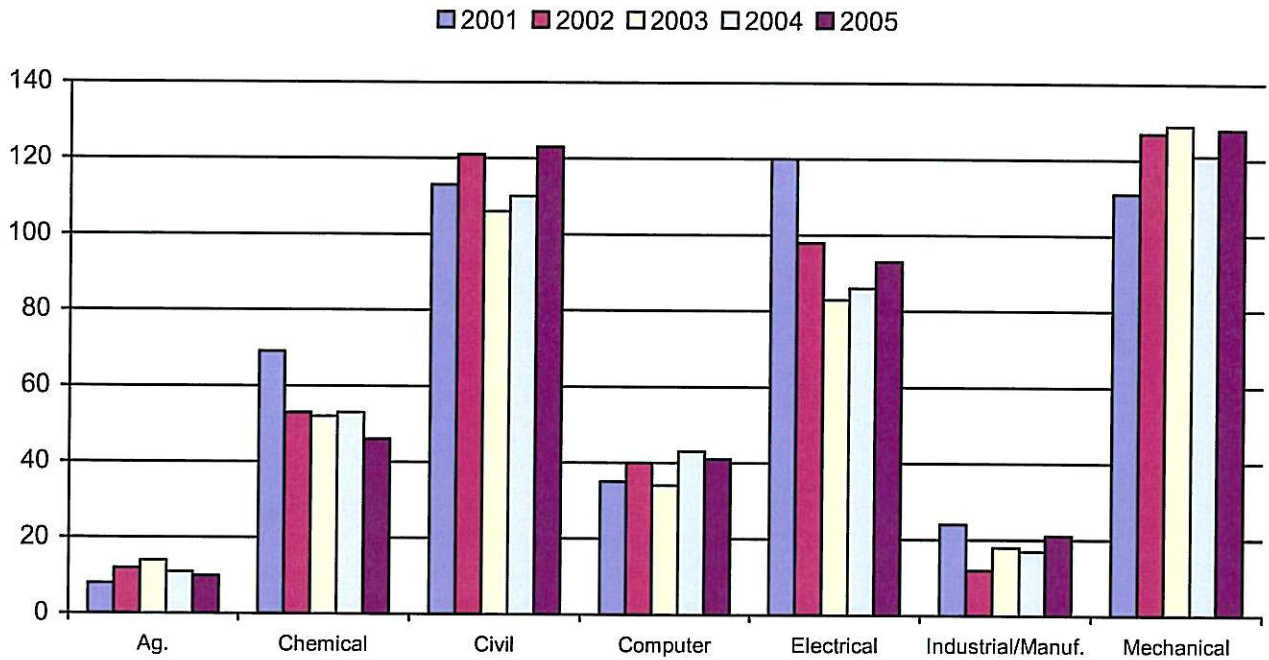
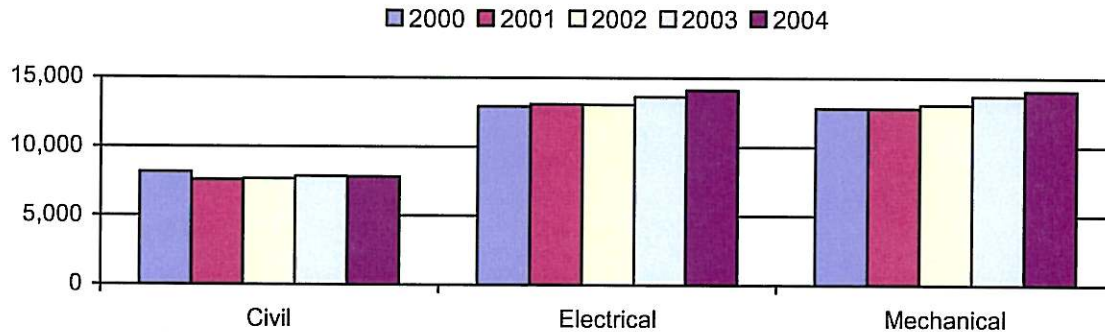


Figure 4. Baccalaureate Engineering Degrees by Discipline, U.S.



Source: NCES Condition of Education 2005, Table 282



Table 4 - Percentage Change in Engineering Baccalaureate Degrees Awarded

<b>Engineering Discipline</b>	<b>KY 2001-2004</b>	<b>U.S. 2001-2004</b>	<b>KY 2001-2005</b>
Civil Engineering	-3%	3%	9%
Electrical, Electronics & Communications Engineering	-28%	8%	-22%
Mechanical Engineering	9%	10%	15%

Relative to national baccalaureate degree reports it is evident that the Kentucky change patterns in civil and mechanical engineering reflect national trends for those disciplines (NCES, Digest of Education Statistics, 2005, Table 282). Kentucky's decline in electrical engineering degrees counters the national trend of increasing electrical engineering degrees during the same time period. Although Kentucky's percentage of change over the 4-year period 2001-2005 is positive, no comparable U.S. data is available.

Table 5 - Joint Engineering Baccalaureate Programs  
(Civil, CIP 14.0801, Electrical, CIP 14.1001; Mechanical, CIP 14.1901)\*

Degree Title	Research Doctoral Institution	Degree	Comprehensive Institution	Degree
	<b>Non-Joint Programs</b>		<b>Joint Programs**</b>	
Bachelor of Science, Electrical Engineering	University of Louisville	BEE	Murray State University	BS
Bachelor of Science, Electrical Engineering		BEE	Western Kentucky University	BS
Bachelor of Science, Civil Engineering	University of Kentucky	BSCE	Western Kentucky University	BS
Bachelor of Science, Mechanical Engineering		BSME	Western Kentucky University	BS

\* CIP is the Classification of Instructional Programs coding based on the U.S. Department of Education, National Center for Education Statistics taxonomy.

\*\* Joint Programs at MuSU and WKU only.

### Joint Engineering Baccalaureate Programs

Three engineering disciplines were targeted to establish joint engineering baccalaureate programs between selected comprehensive and research universities. Civil and mechanical engineering degrees were established at WKU through collaborations with UK and UofL. MuSU offers an electrical engineering baccalaureate with the cooperation of UofL.

Engineering students at MuSU have an alternative to the joint ETE program in the ABET-accredited engineering physics program. Since 2000, MuSU's engineering physics program enrollment has grown from 54 to a peak of 101 in 2004, and the program has graduated 61 students in the past six years. MuSU also is a partner in delivering UK's two engineering degree programs at Paducah, with five of more than a dozen faculty having joint appointments with both institutions. From 2000-2006, the Paducah programs produced 93 graduates and currently have an enrollment of 90 students. MuSU also produces technology graduates who are in high demand in the industrial in the industrial and manufacturing sectors of west Kentucky. In 2005, nearly 600 students were enrolled in these technical programs, producing 473 graduates.

Table 6a - Baccalaureate Degrees in Civil, Electrical and Mechanical Engineering Programs,  
Unduplicated, All Degrees Combined

Degrees Conferred	2000	2001	2002	2003	2004	2005	2006	Total
MUSU								0
UK	249	239	224	222	197	197	198	1526
UofL	102	105	122	96	92	117	115	749
WKU					28	30	26	84
Total	351	344	346	318	317	344	339	2359

Table 6b - Civil Engineering

Degrees Conferred	2000	2001	2002	2003	2004	2005	2006	Total
UK	96	85	85	80	78	69	75	568
UofL	27	28	36	26	24	39	28	208
WKU					8	15	9	32
Total	123	113	121	106	110	123	112	808

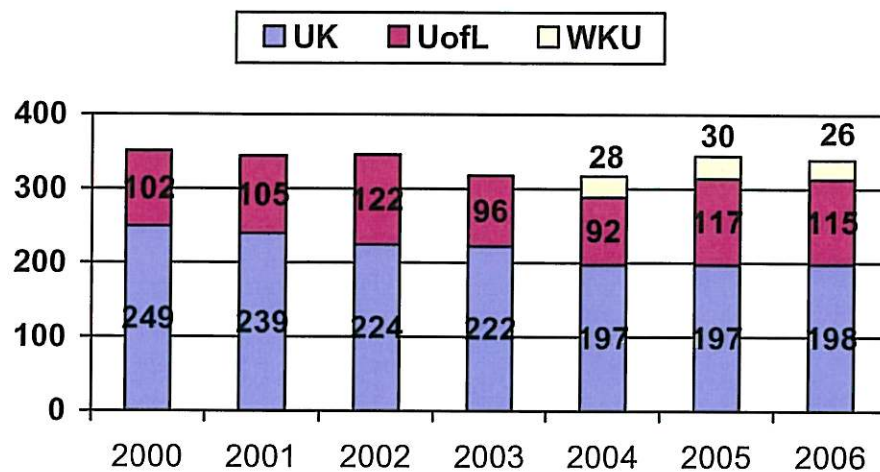
Table 6c - Electrical Engineering

Degrees Conferred	2000	2001	2002	2003	2004	2005	2006	Total
MUSU								0
UK	72	75	53	52	48	53	41	394
UofL	37	45	45	31	30	36	46	270
WKU					8	4	5	17
Total	109	120	98	83	86	93	92	681

Table 6d - Mechanical Engineering

Degrees Conferred	2000	2001	2002	2003	2004	2005	2006	Total
UK	81	79	86	90	71	75	82	564
UofL	38	32	41	39	38	42	41	271
WKU					12	11	12	35
Total	119	111	127	129	121	128	135	870

Figure 5. Total Baccalaureate Degrees Conferred in Joint Engineering Programs



#### Joint Engineering Program Baccalaureate Degrees

Because the students are receiving a degree from two institutions, unduplicated counts of degrees are reported in tables 6a through 6d. Figure 5 displays the total engineering degrees conferred by institution each year since 2000. Starting in 2004, WKU conferred degrees in all three programs. MuSU has not yet graduated any students from their joint program. In each of these engineering fields UK's output declined between 2000 and 2005. UK-Paducah campus showed stable degree output.

Table 7a - Fall Semester Enrollment in Baccalaureate Engineering Technology Disciplines  
Kentucky, 2000 – 2005

Program	2000	2001	2002	2003	2004	2005	5-Year Percent Change
Mechanical Engineering/Mechanical Technology	64	97	104	132	1		
Electrical/Electronic/Electromechanical	200	188	180	182	97	99	-51%
Environmental Engineering/Environmental	30	26	30	29	22	22	-27%
Architectural Engineering Technology	201	199	200	220	145	188	-7%
Occupational Safety and Health Technology	166	159	156	149	143	157	-5%
Water Quality/Wastewater Management/Recycling	119	107	113	105	129	117	-2%
Industrial/Manufacturing Technology	577	526	595	623	678	647	12%
Civil Engineering Technology	160	201	205	210	159	183	14%
Computer/Computer Systems/Networking	46	79	89	91	86	78	70%
<b>TOTAL</b>	<b>1563</b>	<b>1582</b>	<b>1672</b>	<b>1741</b>	<b>1460</b>	<b>1491</b>	<b>-5%</b>

Table 7b - Fall Semester Enrollment in Baccalaureate Engineering Disciplines  
Kentucky, 2000 - 2005

Program	2000	2001	2002	2003	2004	2005	5-Year Percent Change
Applied Science-Engineering Transfer	43	43	39				
Engineering, General			17	17	6	3	
Biomedical/Medical Engineering						21	
Chemical Engineering	382	322	296	303	275	283	-26%
Computer Engineering, General	402	415	371	371	340	314	-22%
Agricultural/Biological Engineering and Bioengineering	65	63	74	70	74	63	-3%
<b>Electrical, Electronics and Communications Engineering</b>	541	519	560	504	568	563	4%
Industrial/Manufacturing Engineering	77	92	98	103	83	86	12%
<b>Civil Engineering, General</b>	598	578	583	625	670	700	17%
<b>Mechanical Engineering</b>	806	814	846	927	1151	1176	46%
Engineering Physics	54	64	72	93	101	84	56%
Materials Engineering	25	19	27	30	46	49	96%
Mining and Mineral Engineering	23	24	50	53	55	71	209%
<b>Total</b>	<b>3016</b>	<b>2953</b>	<b>3003</b>	<b>3096</b>	<b>3369</b>	<b>3413</b>	<b>13%</b>

**Bold** indicates joint engineering discipline.

### Engineering and Engineering Technology Enrollment Trends

Although enrollments by academic program do not precisely reflect student intentions, the data provide general trends of the potential supply of graduates. Large program enrollments are considered an important input but alone, without a high rate of successful completions, will not meet the goals of the statewide engineering strategy.

Based on the figures in Table 7a and 7b differences are evident in enrollment trends between engineering and engineering technology programs. The closure of WKU's mechanical engineering technology with the availability of their mechanical engineering program is evident in the mechanical engineering enrollment patterns. Similarly, electrical engineering technology has declined since 2000 while electrical engineering has increased. The opposite trend is evident in computer engineering, which has decreased, while computer engineering technology program enrollment has increased. Civil engineering and industrial/manufacturing engineering enrollments have grown in both degree programs. MuSU's engineering physics program enrollment has also increased since 2000. Chemical engineering enrollment has been reduced by one quarter since 2000.



Table 8 - Joint and Research Engineering Program Baccalaureate Unduplicated Enrollment

Engineering Discipline		Civil		Electrical		Mechanical		Total	
		2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Joint	MUSU			4	17			4	17
	WKU	99	121	83	89	164	167	346	377
Research	UK	409	410	305	275	605	632	1,319	1,317
	UofL	253	252	260	251	508	529	1,021	1,032
Total		761	783	652	632	1,277	1,328	2,690	2,743

Enrollments in the joint engineering programs, similar to degree reports, also were unduplicated. Enrollment in the joint programs at WKU was up to 377 students during the 2005/06 academic year (Table 8) and the WKU applicant count in academic year 2005/06 was the highest to date (Table 9). MuSU reported four enrolled students in 2005 with an increasing applicant pool.

Table 9 - Joint Engineering Program Baccalaureate Applicants

Year	2001-02	2002-03	2003-04	2004-05	2005-06
MuSU		4	10	17	
WKU	52	138	151	137	162
Total	52	138	155	147	170

Source: Murray State University and Western Kentucky University

Over the last five years of admission to the joint baccalaureate engineering programs at the comprehensive universities, applications have more than tripled (see Table 9) totaling 179 applicants in 2005-06. WKU has substantially more applicants than MuSU.

Table 10a - KCTCS Transfer Students Admitted to MuSU and WKU Engineering Programs

Year	2001-02	2002-03	2003-04	2004-05	2005-06
Total	6	10	16	14	21

Source: Murray State University and Western Kentucky University

Table 10b - KCTCS Transfer Students Admitted to Research Institutions' Engineering Programs

	2000	2001	2002	2003	2004	2005	% Change 2000- 2004	% Change 2000- 2005
UK	194	173	191	150	142	108	-27%	-44%
UofL *	24	31	26	34	24	22	0%	-8%
<b>Totals</b>	<b>218</b>	<b>204</b>	<b>217</b>	<b>184</b>	<b>166</b>	<b>130</b>	<b>-24%</b>	<b>40%</b>

Source: University of Kentucky and University of Louisville, 2006.

### Transfers from Community and Technical College System

The count of entering transfer students from KCTCS to the comprehensive university engineering programs has increased each year with the exception of a slight decline 2004-05 (see Table 10a) with twenty-one students being admitted in 2005-06. However, a recent review of engineering program admissions at UK reported a significant decline between 2000 and 2004 in the number of KCTCS transfer students enrolling in the college (See Table 10b). UofL's transfer student numbers indicate a stable number of transfers from 2000-2004

Two out-of-state but nearby engineering programs enroll very few Kentucky residents. Southern Illinois University at Carbondale enrolled three Kentucky residents in fall semester 2005 while the University of Tennessee at Martin enrolled five Kentuckians.

**Table 11 - Kentucky Engineering Schools' Fundamentals of Engineering  
Examination Pass Rates**

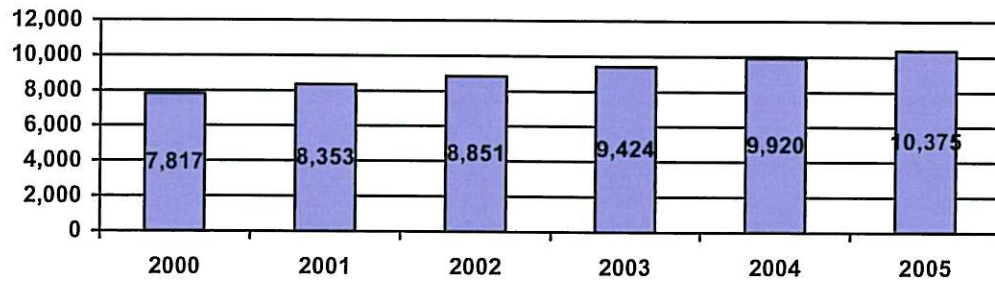
	UK			UofL			MuSU			UK-Paducah			WKU		
Exam	N	N	Pass	N	N	Pass	N	N	Pass	N	N	Pass	N	N	Pass
Date		Pass	Rate		Pass	Rate		Pass	Rate		Pass	Rate		Pass	Rate
1998	69	50	72%	43	37	86%	0	0		0	0		0	0	
1999	161	121	75%	70	53	76%	1	1	100%	0	0	N/A	0	0	N/A
2000	136	108	79%	46	35	76%	13	13	100%	0	0	N/A	0	0	N/A
2001	124	106	85%	53	39	74%	5	4	80%	5	5	100%	0	0	N/A
2002	113	92	81%	41	32	78%	8	8	100%	5	4	80%	0	0	N/A
2003	134	115	86%	38	33	87%	0	0	N/A	9	9	100%	4	4	100%
2004	153	123	80%	29	25	86%	0	0	N/A	0	0	N/A	18	14	78%
2005	149	99	66%	38	31	82%	10	6	60%	12	9	75%	17	13	76%
<b>Totals</b>	<b>1040</b>	<b>814</b>	<b>78%</b>	<b>358</b>	<b>285</b>	<b>80%</b>	<b>37</b>	<b>32</b>	<b>86%</b>	<b>31</b>	<b>27</b>	<b>87%</b>	<b>39</b>	<b>31</b>	<b>79%</b>

Source: The Kentucky State Board of Licensure for Professional Engineers & Land Surveyors

### **State Engineering Strategy Contribution to the Workforce**

Program outcome data, other than degrees conferred, are somewhat limited. The Kentucky State Board of Licensure for Professional Engineers & Land Surveyors annually provides Fundamentals of Engineering Examination results by institution to the Council (Table 11). This is the first exam that potential licensees take, usually in their senior year or just after graduation. Examinees are then required to complete four years of experience before taking the second exam. Fundamentals examination pass rates of WKU students and graduates of the joint engineering programs are comparable to the research universities. MuSU pass rates reflect outcomes of students and graduates in the existing engineering physics program and exceed the general pass rates of the research universities. National pass rates are based on selected examination modules and overall national pass rate standards are not available. The total count of Kentucky students sitting for the exam increased from 195 students in 2000 to 226 in 2005, an increase of 16 percent.

Figure 12. Licensed Engineers in Kentucky



Source: The Kentucky State Board of Licensure for Professional Engineers and Land Surveyors

The number of licensed engineers in KY increased by 33 percent between 2000 and 2005 (Figure 12). These figures include licenses awarded by both initial licensure and reciprocity.

One of the primary goals of the engineering strategy is to increase the number of baccalaureate engineers in Kentucky. Detailed and comparable placement data for joint program graduates across institutions are not available. Generally, UK and UofL report roughly 70 percent of engineering baccalaureate graduates employed in Kentucky, except for electrical engineers that are closer to 60 percent. WKU reported high placement rates for the 2004 class of joint engineer program graduates but found placement rates between 50 and 54 percent for electrical and mechanical engineering graduates in 2005.



## **APPENDIX IV**

### **FISCAL REPORTING BY INSTITUTION**

JOINT ENGINEERING PROGRAMS  
FISCAL REPORTING  
2002-2006

	INCOME											
	FY 03				FY 04				FY 05			
	MUSU	UK	UoL	WKU	MUSU	UK	UoL	WKU	MUSU	UK	UoL	WKU
<b>Carryforward</b>												
State Funds (Engineering Incentive Trust)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 250,000	\$ 115,110	\$ -	\$ 140,200	\$ 250,000	\$ 193,856	\$ -
Tuition/Fees (from students in the program)	\$ -	\$ 250,000	\$ 250,000	\$ 375,000	\$ 250,000	\$ 250,000	\$ 250,000	\$ 375,000	\$ 125,000	\$ 250,000	\$ 250,000	\$ 375,000
Match, if any (Institution, Federal)	\$ 3,000	\$ -	\$ -	\$ 670,800	\$ 13,700	\$ -	\$ -	\$ 989,150	\$ 39,800	\$ -	\$ -	\$ 1,340,880
<b>Totals</b>	\$ 303,000	\$ -	\$ -	\$ 456,024	\$ 164,600	\$ 1,707	\$ -	\$ 1,493,797	\$ 78,300	\$ 38,584	\$ -	\$ 453,713
	\$ 312,000	\$ 250,000	\$ 250,000	\$ 1,501,824	\$ 428,300	\$ 251,707	\$ 250,000	\$ 2,857,947	\$ 243,100	\$ 288,584	\$ 250,000	\$ 2,169,593
<b>EXPENSES</b>												
Personnel Total	\$ 312,000	\$ -	\$ 112,414	\$ 1,011,023	\$ 318,100	\$ 228,446	\$ 158,315	\$ 1,103,231	\$ 335,900	\$ 252,951	\$ 151,365	\$ 1,309,717
Faculty	\$ 310,900	\$ -	\$ 88,000	\$ 945,023	\$ 315,900	\$ 150,641	\$ 121,853	\$ 995,565	\$ 333,400	\$ 191,802	\$ 96,593	\$ 1,188,436
RA/TA	\$ 1,100	\$ -	\$ -	\$ -	\$ 2,200	\$ 56,515	\$ -	\$ -	\$ 2,500	\$ 39,649	\$ 14,318	\$ -
Other	\$ -	\$ -	\$ 24,414	\$ 66,000	\$ -	\$ 21,290	\$ 36,462	\$ 107,666	\$ -	\$ 21,500	\$ 40,454	\$ 121,281
Scholarships	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 4,842	\$ -	\$ -	\$ -	\$ -	\$ -
Operating	\$ -	\$ -	\$ 22,476	\$ 490,801	\$ 110,200	\$ 23,261	\$ 8,097	\$ 1,754,716	\$ 47,400	\$ 35,633	\$ 5,849	\$ 859,876
Other	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
<b>Totals</b>	\$ 312,000	\$ -	\$ 134,890	\$ 1,501,824	\$ 428,300	\$ 251,707	\$ 171,254	\$ 2,857,947	\$ 383,300	\$ 288,584	\$ 157,214	\$ 2,169,593
<b>Carry Forward 2007</b>	\$ -	\$ 250,000	\$ 355,898	\$ -								